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EFFECTS OF THINNING ON GROWTH AND YIELD

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ABSTRACT. — Comparative studies of noncommercial and commercial thinnings covering an 18-year period (on the Boise Cascade Corporation Experimental Forest near Loman, Minnesota) demonstrate how quaking aspen diameter growth was increased by thinning thus shortening the rotation.

A 12-year-old noncommercial thinning in an aspen sucker stand and a commercial thinning in a 32-year-old merchantable stand demonstrate how cultural treatment can shorten the rotation age and increase the production of veneer or saw logs in aspen stands.

NONCOMMERCIAL THINNING

To illustrate what can be accomplished by a noncommercial thinning let's examine such a thinning in quaking aspen sucker stand on our experimental forest. A well-stocked aspen stand (site index 85 to 90) was clearcut during the fall and winter of 1953-54. Seven growing seasons later, six 1/10-acre plots — which were as similar as possible in average tree diameter, stocking, and site — were established in the spring of 1960 in the aspen sucker stand that resulted from the clearcut. The area outside each 1/10-acre plot was expanded to ½ acre to serve as a buffer zone and given equal treatment.

Three of these permanent plots were designated as reserve or control plots and three were thinned before the growing season in the spring of 1960 reducing the stem count from 3,750 to 695, giving an 8 by 8 foot spacing and saving the best dominant and codominant trees.

Two of the thinned plots were axe thinned. The work required 9.5 man hours per acre. The other was thinned with 2,4,5-T herbicide. Although this thinning was successful, the herbicide was translocated through the root system to the residual trees, inhibiting growth for a number of years. Therefore, data from this plot were not used.

All trees were remeasured at d.b.h. to 100th inch each fall following the growing season.

Annual average d.b.h. growth in the thinned plots fluctuated from 0.04 to 0.38 inch and the unthinned or control plots from 0.05 to 0.20 inch. The low point in growth was reached during the 1971 growing season when most of the trees were completely defoliated by the tent caterpillar *(Malacosoma disstria)*.

The average diameter growth on the axe-thinned plots has exceeded that on the control plots since thinning by 1.39 inches and presently has a volume in trees 5 inches d.b.h. and larger of 10.50 cords compared to 1.20 cords on the unthinned plots.

Let us assume that d.b.h. growth will continue at the same average rate as it has in the 12 years since thinning. Projecting the average growth of each individual tree on the thinned plots will give an average diameter of 6.3 inches in 6 years at age 25. A commercial clearcut could be made at that time yielding approximately 37 cords per acre. It would take the control plots considerably longer to approximate the same average diameter and cordage. We have thus significantly reduced the commercial rotation with the noncommercial thinning.

Although one study (Noreen 1968) questions the possibility of a net monetary return from precommercial thinning and another (Sorenson 1968) indicates poor diameter growth for crop trees in a thinned stand, it would seem from our study that more comprehensive research in noncommercial thinning is warranted if we want to reduce rotation or increase diameter.

COMMERCIAL THINNING

In 1954 a commercial thinning experiment was established in two separate units known as Unit I and Unit II at different locations on our experimental forest. The stands on these units covered a total of 12.1 acres, were very similar, and had a site index of 85 to 90. The average age in Unit I was 31 years and the average age in Unit II was 34 years. Each unit was divided into three equal strips, one designated for clearcutting, one for partial cutting, and one for reserve as a control. Two 1/10th-acre permanent plots were established within each strip to measure results. All 12 plots were measured prior to treatment in the spring of 1954. The clear and partial cuts were made in the spring in Unit I and in the fall in Unit II.

The clearcuts removed an average of 50.3 cords and 124.57 square feet of basal area per acre and the partial cut removed about half the 593 stems and 27.86 cords from the total of 57.76 cords of volume (table 1).

The original plan in the partial cut areas was to thin from below to an approximate 13 by 13 foot spacing and 65 to 70 square feet of basal area. But it was found that a salvage of diseased or defective trees just about took care of the thinning with a basal area cut of 60.92 square feet and a final reserve of 69.99 square feet. Because the salvage of defective trees did not always leave uniform spacing, a few openings larger than desired resulted. Unfortunately, some trees on the north side of these openings suffered sunscald.

The final clearcut was made in Unit II after the growing season in 1970 at 50 years of age; the scaled, cut volumes exceeded the plot volumes.

Results

By 1970 aggregate volume in the partial-cut areas exceeded volume in the control by 17 cords, a net gain of 8.70 cords since 1954. The d.b.h. of the average tree in the partial-cut areas exceeded the average tree in the control by 1.73 inches. Net diameter growth in the partial cut exceeded that in the control by 1.45 inches.

Veneer Potential Compared

In order to determine the veneer potential of the partial-cut areas compared to the control strips, veneer bolts on all plots were tabulated by size in 1969 (table 2). Bolts were then converted to finished veneer values (including residues) as reported by Noreen and Hughes (1968). It is evident that the partial cutting has had a marked influence on the size and value of veneer bolts.

Table 1. — *Plot data for aspen cutting study — average of two units*

	Per acre data1/			Average	Age
	Trees	Volume	Basal area	d.b.h.	
	Number	Cords	Square feet	Inches	Years
Clearcut strip (Fall 1954)	525	50.32	124.57	6.56	32.5
Partial-cut strip:					
Before cutting (1954)2/	592	57.76	141.39	6.77	32.0
Cutting	288	27.86	60.92	6.25	--
After cutting (1954)	252	29.52	69.99	7.43	32.5
Fall 1970	190	52.84	125.17	10.99	49.0
Cumulative yield		80.70			
Mean annual growth (49 years)		1.65		.23	
Reserve strip (control)					
At time of cutting	542	49.03	119.49	6.49	32.5
Fall 1970	318	63.65	148.66	9.26	49.0
Mean annual growth (49 years)		1.30		.19	

1/ All volumes computed by formula on an individual tree basis.
2/ The total of the trees and basal areas cut plus those remaining is not equal to those previous to cutting because of natural mortality and logging damage between initial measurement and measurement after cut.

Table 2. — *Veneer production for an uncut aspen stand compared to a partial-cut stand after 15½ growing seasons*

Top diameter (inches, inside bark)	Conversion return per bolt	Control		Partial cut	
		Bolts	Total value	Bolts	Total value
	Dollars	Number	Dollars	Number	Dollars
8	0.94	45	42.30	34	31.96
9	1.42	42	59.64	32	45.44
10	2.04	14	28.56	22	44.88
11	2.89	6	17.34	19	54.91
12	4.03	-	-	7	28.21
13	5.40	-	-	4	21.60
Total value on plots			147.84		227.00
Veneer value per acre			369.60		567.50
Total pulpwood value (at $1.00/cd., 1954 and $1.25/cd., 1969)			79.56		92.19

Clearcut Strips

The first growing season following the 1954 clear-cutting the sucker counts showed an average of 15,950 stems per acre. This had been reduced by natural mortality to 1,825 stems in 1971.

In the fall of 1971 the average dominant tree had a d.b.h. of 3.21 inches and an average height of 36 feet so these stands are already well on the way toward the next crop and have a 17½ year average jump on the reserve and partially cut areas. Only time will tell whether an early clearcut is economically more advantageous for pulpwood production than a partial cut at the same age. This should prove a fertile field for studies by economists.

COMBINING THE NONCOMMERCIAL THINNING WITH THE COMMERCIAL THINNING

If we are aiming for a saw-log or veneer market, what potential is theoretically possible if we combine a noncommercial thinning with a commercial thinning or partial cutting? We realize the many mensurational, biological, and climatic pitfalls involved in making straight growth projections based on the past average growth of individual trees especially when a year of practically no growth, due to the tent caterpillar, is injected into the averages.

Fully aware of the limitations involved, we made an adjusted projection based on the average past growth of individual trees in our sucker thinning and the growth information from our aspen commercial cutting experiment (1954-1970). Potential mortality trees (six of the largest trees on one plot, alive but infected with hypoxylon stem canker) in the present sucker stand were eliminated and growth projected by tree to age 32, with some adjustment for additional mortality based on this and other noncommercial thinning studies.

I then made a theoretical commercial partial cut reserving crop trees selected in the field on the two axe-thinned plots and simulating the partial cut in our 1954 aspen cutting study. In all, 385 trees with a volume of 36.15 cords were removed, reducing the stand to 74.28 square feet of basal area per acre (table 3).

The final projection based on growth of individual trees in our 1954-1970 partial-cut study was made to age 50 (table 4). The same experimental forest local volume table was used for all volume calculations.

This shows that our cultural measures have accomplished three things: increased the average stand d.b.h. by 4.53 inches, greatly increased the number of

Table 3.—*Results of theoretical management of an aspen sucker stand originally thinned at age 7 years and partially cut at age 32 years*

ACTUAL STAND

	Per acre data1/ Trees	Volume	Basal area	Average d.b.h.	Age
	Number	Cords	Square feet	Inches	Years
Spring 1960 (following thinning)	695	--	9.63	1.60	7
Fall 1971	675	10.50	86.61	4.84	19
PROJECTED STAND					
Projected to age 32 (Fall 1984)	550	57.75	198.81	8.13	32
Simulated cut, age 32 (Fall 1984)	385	36.15	124.53	7.70	32
Reserve, age 32 (Fall 1984)	165	21.60	74.28	9.08	32
Projected to age 50 (Fall 2002)	148	52.93	158.87	14.03	50
Cumulative yield (Fall 2002)	--	89.08	--	--	--

1/ All volumes computed with an experimental forest local volume table.

Table 4.—*Stand table comparing a 50-year-old untreated stand with a theoretically managed stand on similar site (site index 85-90)*

D.b.h. class1/ (inches)	Control stand: Total trees	Control stand: Basal area per acre	Control stand: Volume2/ per acre	Managed stand: Total trees	Managed stand: Basal area per acre	Managed stand: Volume2/ per acre
	Number	Square feet	Cords	Number	Square feet	Cords
5	10	1.430	0.20	0	--	--
6	43	8.280	2.13	0	--	--
7	28	7.560	2.30	0	--	--
8	35	12.460	3.65	0	--	--
9	43	19.280	5.63	0	--	--
10	43	23.650	7.35	8	4.610	1.36
11	43	28.440	10.45	3	2.230	.66
12	38	28.910	9.38	13	10.620	3.25
13	10	9.470	2.95	29	26.038	8.99
14	5	5.200	1.80	52	57.293	18.87
15	--	--	--	27	34.479	11.52
16	3	3.540	2.40	9	12.314	4.32
17	--	--	--	4	6.164	2.16
18	--	--	--	3	5.126	1.80
Total	301	148.220	48.24	148	158.874	52.93
Average basal area		.492			1.073	
Average d.b.h.		9.50			14.03	

1/ Trees 5 inches and larger.
2/ All volumes computed with a local volume table believed to be conservative.

stems in the larger diameters, and increased the total cumulative yield by more than 40 cords (theoretical thinning at 32 years, 36.15 cords, plus final projected volume of 52.93 cords). While there may be some question concerning such a large comparative increase in cumulative cordage, there is little question that significant increases in diameter can be accomplished by such management practices.

CONCLUSION

These comparative noncommercial and commercial thinnings and those carried on by others (Day in Upper Michigan, Steneker and Jarvis in Manitoba, and Zasada on the Chippewa National Forest in Minnesota) have shown that, *under the right conditions,* aspen has excellent management potential, especially if the aim is to supply a saw-log or veneer market. Because of its suckering ability, there are no planting or release costs and the larger average diameters should reduce logging costs. Thus for stands close to the mill more intensive culture is within the realm of economic feasibility. Government agencies with a subsidized labor force, should carefully consider more intensive management of aspen because the day of aspen surpluses, especially of saw-log or veneer size and quality, is rapidly drawing to a close.

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